Drowned landscapes of the Belgian Continental Shelf: implications for northwest European landscape evolution and preservation potential for submerged heritage.

Maikel DE CLERCQ[1,*], Tine MISSIAEN[2], David G. MORENO[2], Mieke MATHYS[3], & Marc DE BATIST[1]

1 Renard Centre of Marine Geology, Department of Geology, Ghent University, Krijgslaan 28, building S8, B-9000 Gent

2 Flanders Marine Institute, InnovOcean site, Wandelaarkaai 7, warehouse 48, B-8400 Ostend

3 International Marine & Dredging Consultants N.V., Van Immerseelstraat 66, B-2018 Antwerp

*Corresponding author: maikel.declercq@ugent.be

Keywords: Belgian Continental Shelf, southern North Sea, Quaternary, incised-palaeovalleys, stratigraphy, palaeogeography.

Abstract

For a long period it was considered that the Quaternary sedimentary record of the Belgian Continental Shelf (BCS) was well understood and needed no further attention. However, recent research (De Clercq, 2018; De Clercq et al., 2018; Mathys, 2009) demonstrates that these now drowned landscapes have a much more complicated architecture, comprising of marine, estuarine, coastal, intertidal and fluvial environments, often separated from each other by erosive boundaries. The main driving factors behind the preservation/deposition of this wide range of environments are climate change, glacio-isostasy and sea-level fluctuations, which in turn control the palaeogeographic evolution of northwest Europe.

The unique tectonic position of the BCS between the depositional southern North Sea and the erosive area of the Dover Strait left strong imprints in its preserved record (as erosion in the top of the Paleogene and preservation/erosion within the Quaternary record) that prove to be important for unravelling the palaeogeographical evolution of northwest Europe. Here, we provide a summary of the current stratigraphical and chronological frameworks and provide an overview of the landscape changes preserved in the sedimentary environments of the BCS for the last two glacial-interglacial cycles.

The oldest geomorphic imprints preserved in the stratigraphic record date back to the Penultimate Glacial and are related to the final opening of a glacio-isostatic upwarped remnant Elsterian (MIS 12) land bridge between East Anglia and Belgium-southwest Netherlands. This upwarped area experienced a lag in the Last Interglacial (MIS 5e; Eemian) sea-level rise impacting the development of the southern North Sea at the time. This is demonstrated by the transition of wave- to tide-dominated estuaries along the Eemian palaeoshoreline during the Early-Middle Eemian transition. While Early Glacial global sea levels were already on the decline the former upwarped zone was now also subsiding sustaining high sea levels within the area of the southern North Sea. Climate fluctuations during the following Pleniglacial resulted in the formation of a single merged ice-sheet across the North Sea Basin during the Early and Late Pleniglacial (MIS 4 and 2; 70 ka glaciation and Last Glacial Maximum). This ice mass expansion and its related glacio-isostatic adjustment impacted the drainage network across northwest Europe in such a way that it routed most of its water down to the southern North Sea and the English Channel. The possible formation of ice-marginal lakes and their subsequent drainage had a major impact on downstream

landscapes. This is demonstrated by the presence of far-travelled clasts encountered on the BCS that originate from the Scottish Grampian Highlands and the British East Coast suggesting such a north-south transportation route took place (Dusar, 2014; Dusar et al., 2016). During the Late Glacial period aeolian wind-driven activity resulted in the development of sand ridges. The development of the so-called Maldegem-Stekene sand ridge is believed to be the sole cause of the palaeo-Scheldt River deflection from Ghent-Zeebrugge-Ostend to Ghent-Antwerp, however the impact of glacio-isostasy and how big its role may have been during this deflection has never been accounted for. The final Holocene drowning of the BCS resulted in a dynamic palaeoshorline and the development of a back-barrier environment protected by barrier islands until its final present configuration (Mathys, 2009).

Next to their own sedimentary characteristics some of the aforementioned deposits and landforms provide fossil material and provide additional information of the various palaeoenvironments of the time (interglacial vs. glacial fauna, terrestrial vs. aquatic species, freshwater vs. marine biota) and provide information about possible archaeological preservation (e.g. Cohen et al., 2017). Evidence from the North Sea, such as the Brown Bank and the Eurogeul navigation channel, demonstrate that concentrations of faunal remains appear to be in the same areas as the archaeological remains and provide the first clues as to where archaeological material may be preserved within the wide suite of preserved palaeoenvironments on the BCS. These results have for the first time ever been visualised in archaeological and palaeontological potential maps.

References

Cohen, K.M., Westley, K., Erkens, G., Hijma, M.P., Weerts, H.J.T., 2017. The North Sea. In Flemming C., Harff J., Moura D, Burgess A., Bailey G.N (eds.), Submerged Landscapes of the European Continental Shelf, John Wiley & Sons, Ltd., Oxford, United Kingdom. DOI: 10.1002/9781118927823.ch7.

De Clercq, M., 2018. Drowned landscapes of the Belgian Continental Shelf: implications for northwest European landscape evolution and preservation potential for submerged heritage. Published Ph.D Thesis. Ghent University, 331 p.

De Clercq, M., Missiaen, T., Wallinga, J., Zurita Hurtado, O., Versendaal, A., Mathys, M., De Batist, M., 2018. A well-preserved Eemian incised-valley fill in the southern North Sea Basin, Belgian Continental Shelf - Coastal Plain: implications for northwest European landscape evolution. Earth Surface Processes and Landforms. DOI: 10.1002/esp.4365.

Dusar, M., 2014. Lithology of gravel deposits at the seabed East of the Westhinderbank, Royal Belgian Institute for Natural Sciences, Brussels, Belgium.

Dusar, M., Pieters, M., Van Haelst, S., De Clercq, M., Goethals, H., De Ceukelaire, M., Heyvaert, V., 2016. Pleistocene gravels on the Belgian offshore investigated for the composition and provenance, towards a reassessment of the transport models. In 5th International Geologica Belgica Meeting 2016.

Mathys, M., 2009. The Quaternary geological evolution of the Belgian Continental Shelf, southern North Sea. Unpublished Ph.D Thesis. Ghent University, 382 p. https://biblio.ugent.be/publication/716421.